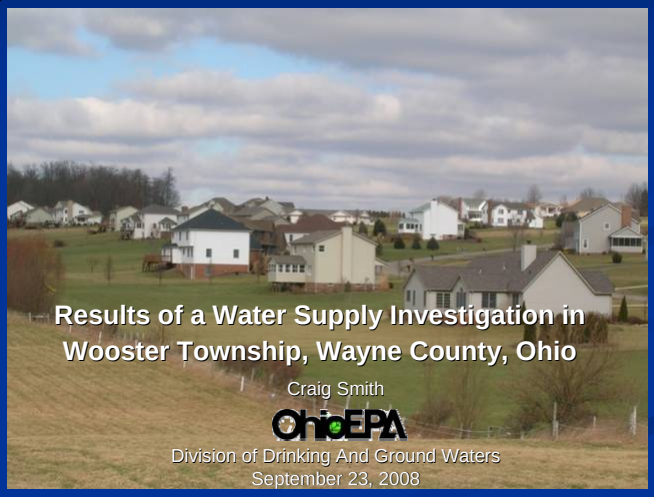
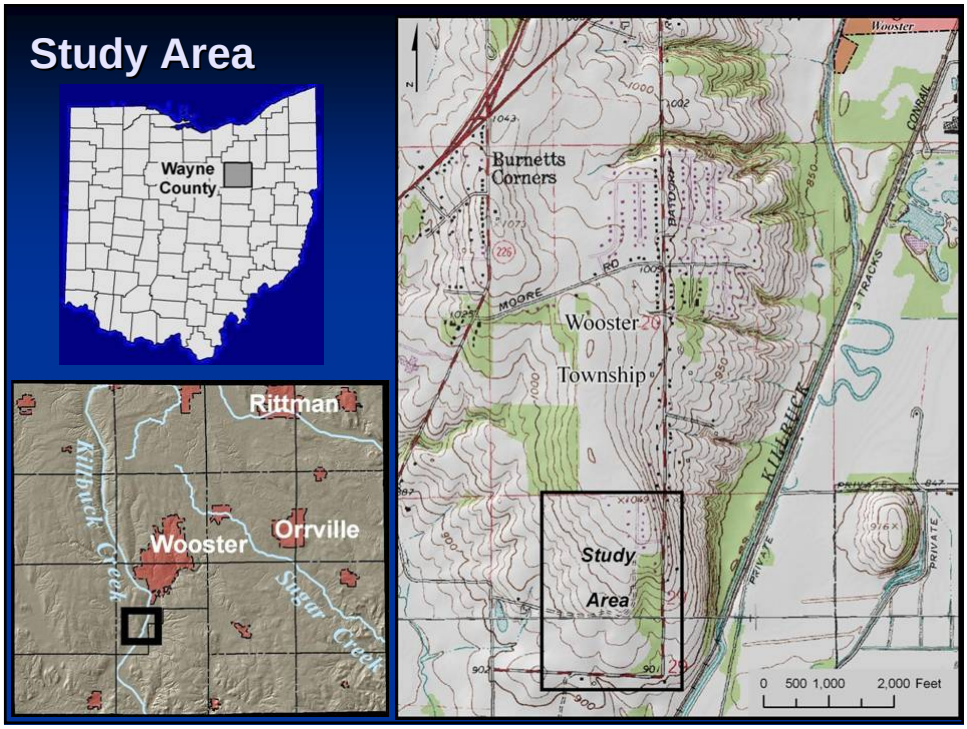
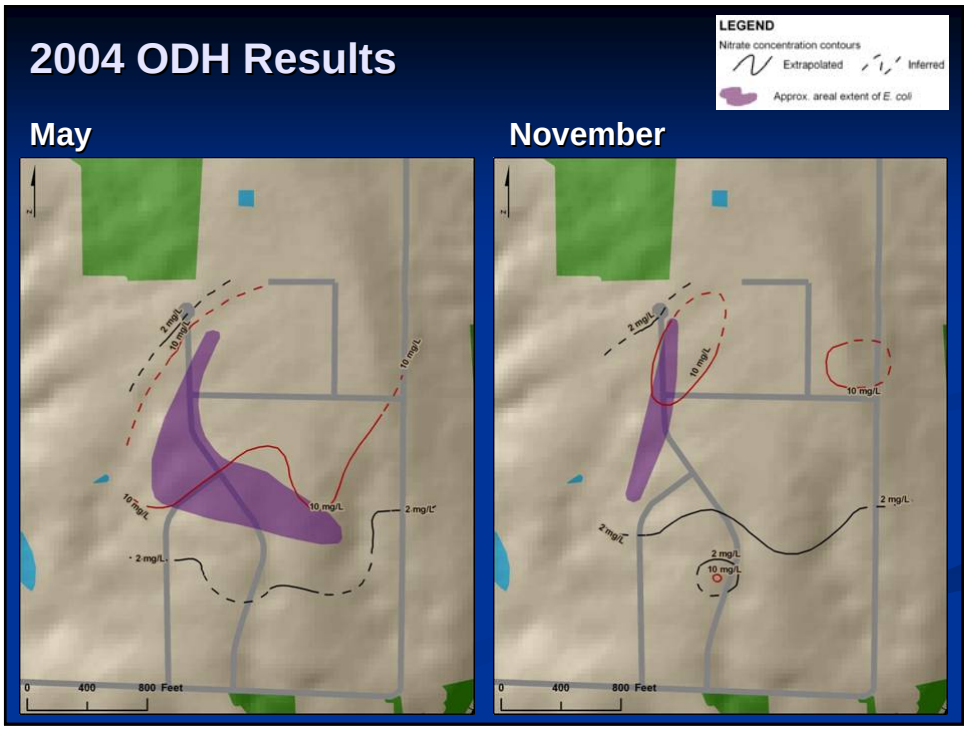
Determining the Source of Ground Water Contamination in a Mixed Agricultural and Residential Area



Presentation Outline

- Study – Location and Purpose
- Ohio EPA Investigation
- Indicators of Most Probable Source
- Summary of Findings
- Acknowledgements

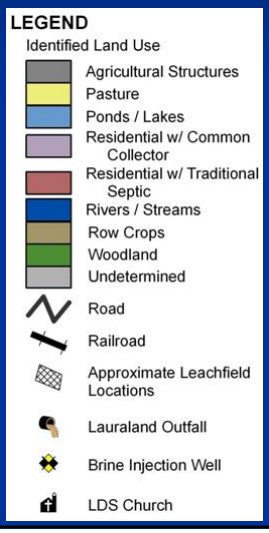

Study Area
Wayne County
Rittman
Killbuck Creek
Wooster
Orrville
Sugar Creek
Burnetts Corners
Wooster
Township
MOORE
RR
TRACKS
KILLBUCK
CONRAIL
PRIVATE
Study Area
0 500 1,000 2,000 Feet


2004 ODH Results
LEGEND
Nitrate concentration contours
Extrapolated
Inferred
Approx. areal extent of E. coli
May
November
2 mg/L
10 mg/L
0 400 800 Feet

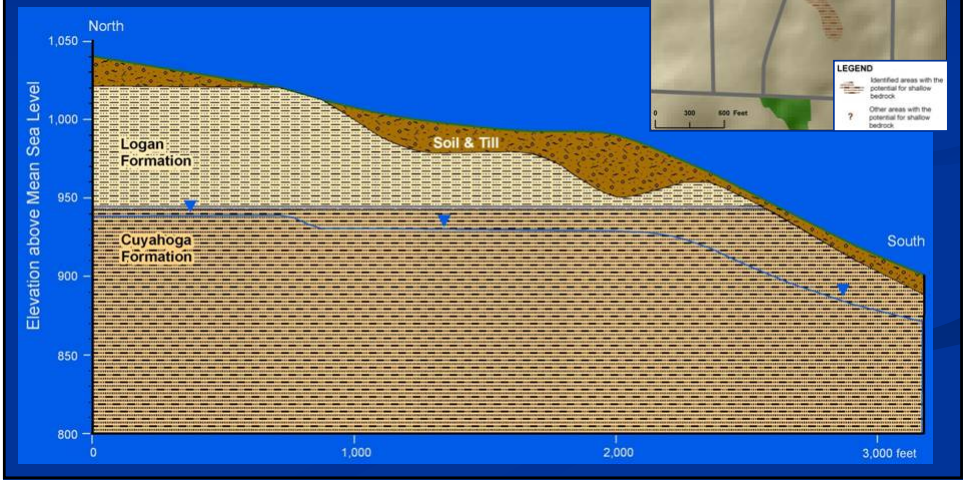
Purpose of Study

- Is local ground water impacted by potential contaminant sources?
  - Do previously observed conditions still exist?
    - Microbiological indicators and nitrate
    - General ground water quality parameters
- If so, what is the most probable source (or sources) of *E. coli* and nitrate contamination?
  - Septic systems and/or other source(s)?
    - Microbiological markers
    - Wastewater compounds & Optical brighteners
    - Bromide / Chloride & Nitrate isotopes

Land Use & Potential Sources



Local Geology

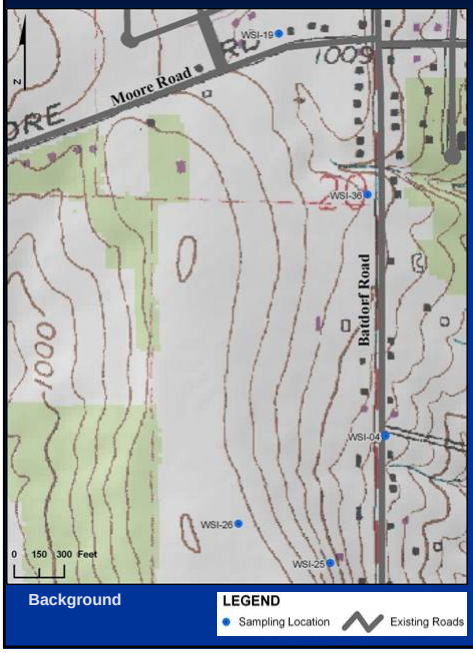


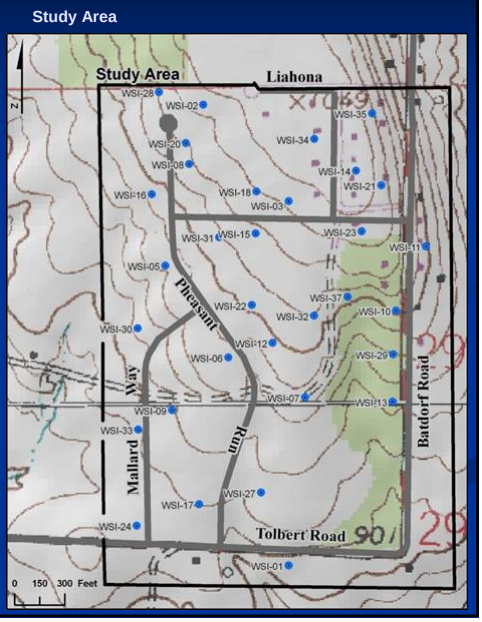
Local Water Table

Sampling Plan

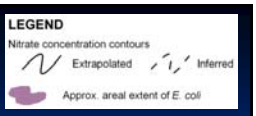
- Phase 1 Sampling – 36 Wells
  - General ground water quality parameters
  - Microbiological indicators and nitrate
- Phase 2 Sampling – 12 Wells
  - Microbiological markers
  - Wastewater & organic compounds
  - Bromide / Chloride
  - Optical Brighteners

Ohio EPA Sampling Locations



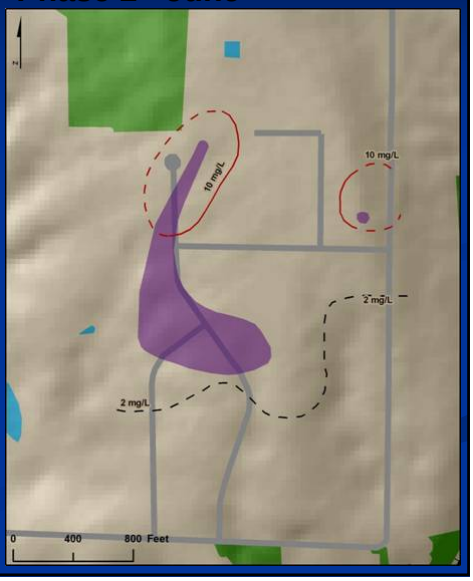


Investigation Results



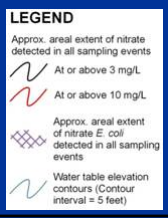
Phase 1 - April

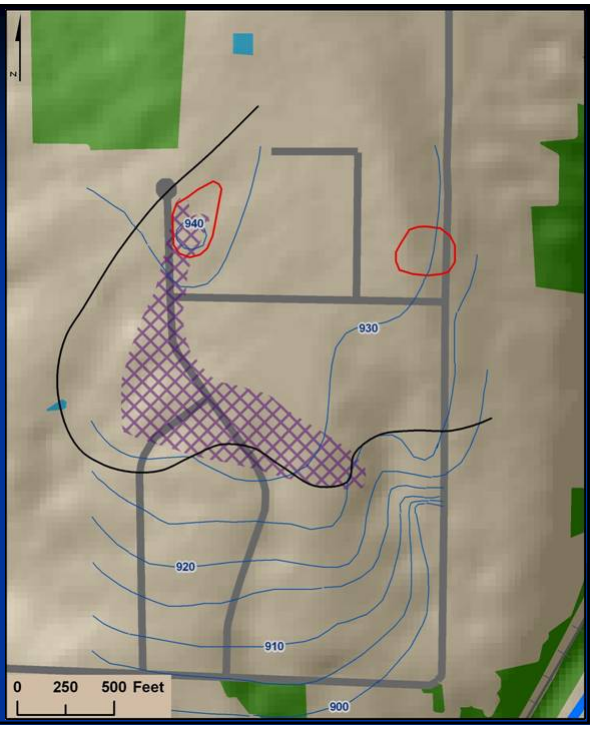
Phase 2 - June



Summary of Impacts

- Highest nitrate concentrations and *E. coli* occur in same areas over time
- Overall area with elevated nitrates fluctuates in size over time
- Northern part of area most likely to experience elevated nitrate levels





Distribution of Potential Sources

- Cannot identify depth to bedrock for individual household sewage treatment systems

Chloride / Bromide Relationship

- Results for most Phase 2 sites fall within range for mixture of sewage and ground water

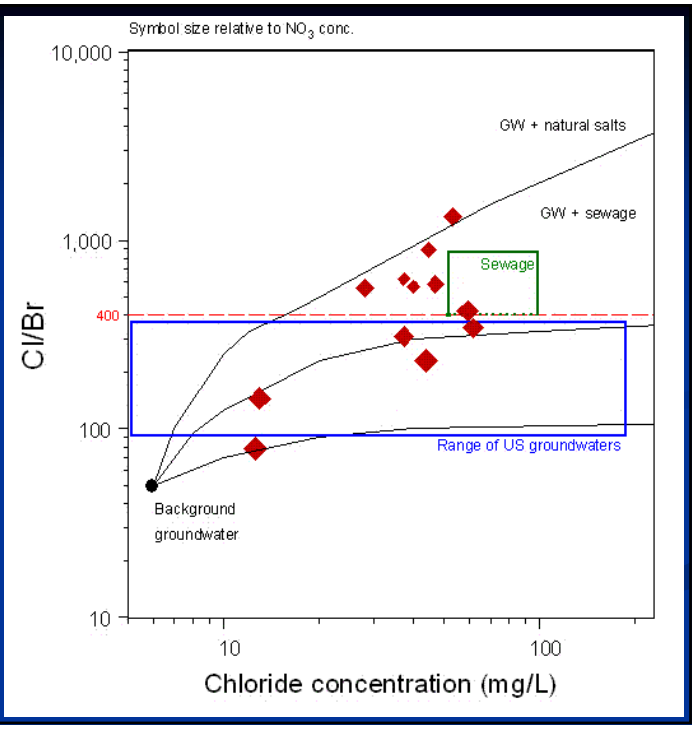
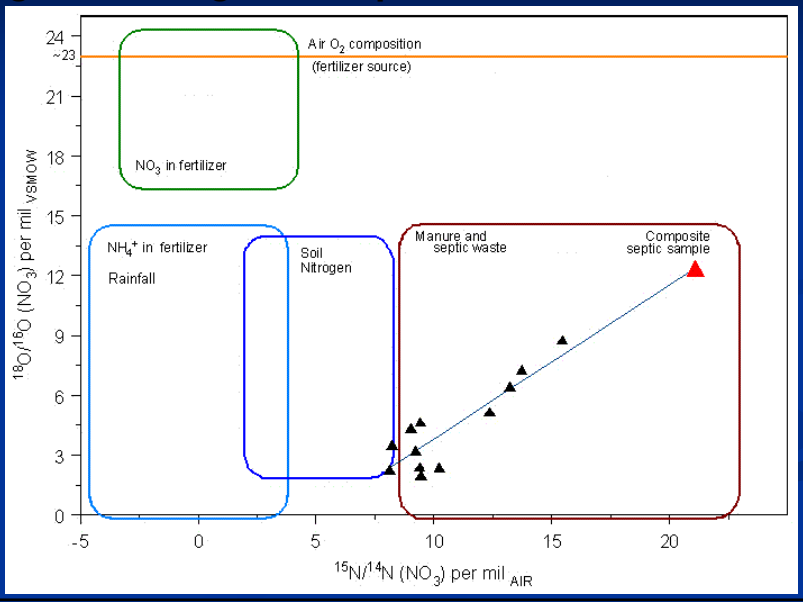
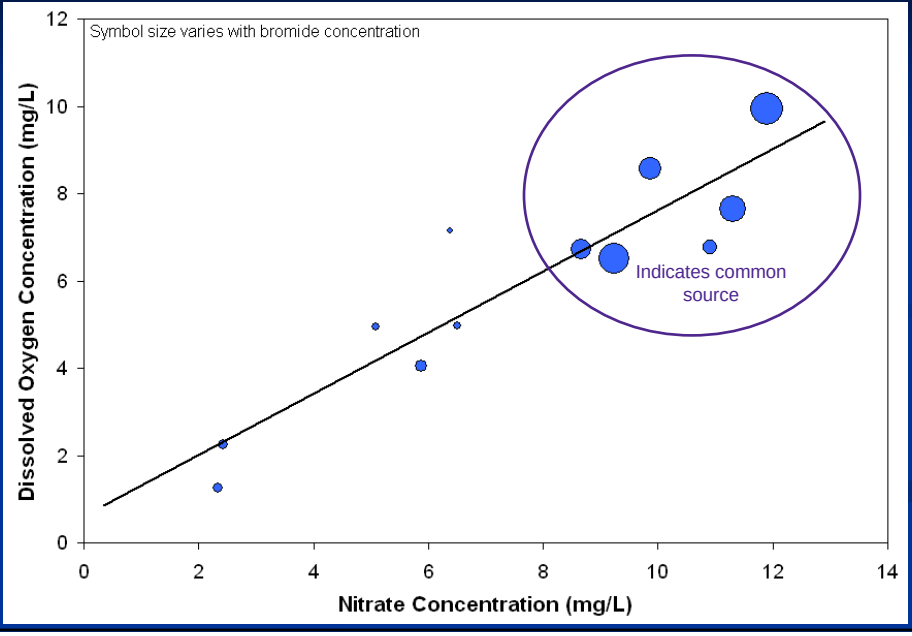


Figure modified from Francey, et. al., 2004

Source Determination -
Oxygen & Nitrogen Isotopes



Correlation Between Nitrate and Bromide



Other Analyses

- Wastewater Compounds
  - Two of 69 compounds detected at very low concentrations
    - Metolachlor - herbicide
    - Caffeine
- Optical Brighteners
  - Method not sensitive enough to detect compounds at extremely low levels
- USGS DNA Studies
  - Bacteria present in insufficient quantities for DNA analysis

Source Determination

Potential Source→ Indicator ↓	HSTS	Manure Application	Fertilizer	Livestock Management	Brine Injection
Location	Probable	Possible	Probable	Not Likely	Not Probable
Persistence	Probable	Possible	Possible	Not Probable	Not Probable
Hydrogeology	Probable	Possible / Not Likely	Probable	Highly Unlikely	Not Probable
Nitrate Concentrations	Probable	Possible	Probable	Not Probable	Not Probable
E. coli	Probable	Probable	Not Probable	Highly Unlikely	Not Probable

Source Determination

Potential Source→ / Indicator ↓	HSTS	Manure Application	Fertilizer	Livestock Management	Brine Injection
Microbiological Indicators	Uncertain	Uncertain	Not Probable	Uncertain	Not Probable
Wastewater Compounds	Uncertain	Not Probable	Not Probable	Not Probable	Not Probable
N/O Isotopes	Probable	Possible	Possible	Not Probable	Not Probable
Br-/Cl-	Probable	Possible	Not Probable	Not Probable	Not Probable
Conclusion	Most Probable	Possible	Possible / Not Likely	Highly Unlikely	Not Probable

Summary

- Fractured bedrock covered by thin soil and till
  - Rapid infiltration to ground water
  - Fractures are pathways for contaminants
- Nitrate and *E. coli*
  - Nitrate > 3 mg/L - human activities; > 10 mg/L - septic source
  - Persistence in same areas indicates constant source
- Most probable source
  - Bromide / chloride ratios consistent with ground water impacted by sewage
  - Nitrate isotopes fall in observed range for ground water impacted by sewage / manure
  - Nitrate isotopes consistent with mixing of soil water and effluent

Acknowledgements

Michael Eggert, Chris Kenah, Amy Klei, Jeff Rizzo, Michael Slattery & Craig Smith

Loretta Firis & Lynnessa Riechart

Denise Dumouchelle & Brian Mailot

Rebecca Fugitt, Phil Pugh, Doug Rogers, Steve Schmidt & Russell Smith

Bill Haiker & Jim Raab

Special thanks must be given to the home owners who participated in the investigation, which would not have been possible without their assistance.

Thank You

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